Session 5 – Cardiovascular Multimodality Imaging Techniques

Friday May 29 – 10.00 – 11.00

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Non invasive ultrasonic chordal cutting

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Objective Chordal cutting targeting leaflet tethering has been described to improve the efficacy of annuloplasty during ischemic mitral regurgitation surgery. Histotripsy is a novel ultrasound based technique for tissue fragmentation through the cavitation generated at the focus of a very intense ultrasonic pulse. We investigate the feasibility of using histotripsy for chordal cutting to avoid cardiopulmonary bypass and invasive surgery in infarcted heart.

Methods Experiments were performed in vitro in explanted sheep heart (N=10) and in vivo in sheep beating heart (N=5, 40±4kg). In vitro, the mitral valve basal chordae was fixed. The ultrasound pulses were emitted from the therapeutic device (1-MHz focused transducer) placed at a distance of 64mm. In vivo, we performed sternotomy and the device was applied on the thorax cavity. We analysed MV coaptation and chordae by real time 3D echocardiography before and after chordal cutting. A postmortem anatomical exploration have been realized to confirm the section of the chordae.

Results In vitro, all the basal chordae were completely cut. The mean procedure time was 6 (±3) minutes. The thickness of the chordae was the main criteria affecting the duration of procedure. In the sheep, central basal chordae of anterior leaflet were completely cut. The mean procedure time was 19 (±9) minutes. By echography, the sectioned chordae was visible and no mitral valve prolapse was found. All the postmortem anatomical exploration of hearts confirmed the section of the basal chordea. No additional lesions were objectified.

Conclusions Noninvasive ultrasound histotripsy succeed to cut mitral valve basal chordae in vitro and in vivo in beating heart. Future investigation will be needed to test this technique on its ability to decrease ischemic or functional MR secondary to leaflet tethering. If positive, this will open the door of completely noninvasive technique for MV repair especially in case of functional MR.

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Monitoring of LVAD implantation and set-up with miniaturized transesophageal echocardiography: Initial experience at La Pitié-Salpêtrière Hospital and possible application fields

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Background Left ventricular assist devices (LVAD) are valuable options for mechanical circulatory support in patients with severe heart failure (HF) as a bridge to cardiac transplantation, to recovery, or as destination therapy. Transesophageal echocardiography (TEE) plays a key role in the management of LVAD patients; either in guiding the device implantation or in the postoperative hemodynamic assessment. The aim of this observational study is to investigate the safety and usefulness of a miniaturized TEE probe designed for continuous hemodynamic monitoring (hTEE, hemodynamic transesophageal echocardiography; ImaCor, Garden City, NY) in hemodynamic assessment of patients undergoing LVAD implantation.

Methods Between June 2014 and September 2014, 7 consecutive patients underwent LVAD implantation for severe HF. hTEE probe was used for continuous hemodynamic monitoring in the pre-, intra- and postoperative periods. All procedures were performed by hTEE-trained physicians.

Results All data were recorded and used without need of further hemodynamic device. The average number of hemodynamic assessment in each patient was of 5.3. The average number of hemodynamic assessment leading to therapeutic changes in each patient was 2.6. The mean duration of hTEE probe insertion was approximately of 20 hours (9 hours, 72 hours). No device complications were noticed during this period.

Conclusions This observation suggest that hemodynamic monitoring using the hTEE system in LVAD patients is feasible and provides valid data after a brief training period. The overall impact of hTEE use in these patients is yet to be determined and further studies are still required.

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Comparison of cardiac magnetic resonance and echocardiography for the assessment of aortic valve area in aortic stenosis

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Background Aortic valve area (AVA) calculated by the continuity equation by echocardiography (CE-TTE) is the method of reference to assess aortic valve stenosis severity (AS). The Hakki's formula (simplified Gorlin formula) is another method, sometimes used during cardiac catheterization to calculate AVA. It can also be adapted to magnetic resonance imaging (CMR) to assess the stenotic AVA as previously demonstrated.

The aim of our study is to investigate using a large number of patients with AS, the accuracy of the "Hakki-CMR" method to determine the severity of AS as compared to CE-TTE and to anatomic AVA by planimetry performed by CMR.

Methods and results Between 2007 and 2014, 390 consecutive patients with AS (mean age 81±10 years, men 55%, mean LVEF= 60±13%, underwent clinically indicated TTE (Philips IE 33,) and CMR (Philips ACHIEVA 1.5 Tesla) within 30 days.

The mean aortic pressure gradient was 43±18 mmHg; the AVA was 0.63±0,25cm^2 by CE-TTE, 0.75±0,30cm^2 using Hakki-CMR and 0.65± 0,18cm^2 by planimetry-CMR.

The mean differences in AVA between different methods were respectively: 1) 0.04cm^2 (95% limits of agreement –0.15 to 0.21, p<0,0001) between Hakki-CMR and CE-TTE, 2) 0.04cm^2 (95% limits of agreement –0.17 to 0.23, p=0,0002), between planimetry-CMR and the CE-TTE, 3) 0,01cm^2 (95% limits of agreement –0.16 to 0.14, p<0,0001) between Hakki-CMR and planimetry.

Conclusion In a large cohort of patients with AS, assessment of AVA using the Hakki's formula by CMR, yielded more reliable results than those obtained using planimetry by CMR, and similar to those obtained using the CE-TTE. Despite the time and cost issue of CMR, the Hakki formula used during flow quantification, is a valuable method that is reliable easy, and fast to apply. It may be highly useful especially in cases of suboptimal echogenicity by TTE and regardless of the valve's degree of calcification.

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Pocket-size ultrasound does not alter the diagnosis of the cardiologist in patients admitted for chest pain in a cardiac unit

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Purpose Chest pain is a very common cause of hospitalization in cardiology departments and is associated with a large variety of cardiac disease.

Abstract 125 – Table 1.

	STEMI % (95% CI)		NSTEMI % (95% CI)	
	Cardiologist	**Cardiologist + pSU**	**Cardiologist**	**Cardiologist + pSU**
Sensitivity	100% (63.1-100)	100% (63.1-100)	100% (93.6-100)	100% (93.6-100)
Specificity	100% (97.3-100)	100% (97.3-100)	55.3% (44.1-66.1)	56.5% (45.3-67.2)
PPV	100% (63.1-100)	100% (63.1-100)	59.6% (49.0-69.6)	60.2% (49.5-70.2)
NPV	100% (97.3-100)	100% (97.3-100)	100% (92.5-100)	100% (92.6-100)

The aim of our study was to evaluate the diagnostic influence provided by a pocket-size ultrasound (pSU) in addition to the usual evaluation (physical examination, troponin levels, and electrocardiogram) in patients hospitalized in cardiac unit for chest pain.

Methods Between December 2012 and December 2013, consecutive patients referred by the emergency department were hospitalized for chest pain in our cardiac care unit. They underwent physical examination, electrocardiogram, routine laboratory tests including troponin, chest X-ray and pSU. The diagnosis of the cardiologist who admitted the patient (cardiologist was compared to diagnosis of the cardiologist taking into account the pSU results (cardiologist + pSU) and to the reference diagnosis at the time of hospital discharge (final diagnosis).

Results Among one hundred forty one patients (91 men) included in our study, 34 patients (24,1%) had a history of coronary artery disease (CAD). The final diagnosis was non coronary chest pain in 80 patients (56.7%) and chest pain from proven coronary origin in 61 patients (43.3%) (8 patients (5.7%) with ST segment Elevation Myocardial Infarction (STEMI), 53 patients (37,6%) with Non-ST segment Elevation Myocardial Infarction (NSTEMI)).

Use of pSU confirmed the initial cardiologist's diagnosis in 21% (30 patients), corrected in only 1% (1 patient) and had no influence in 78% (109 patients). The use of pSU did not significantly change the cardiologists diagnosis in STEMI group and in NSTEMI group *(table 1).*

Conclusion In our study, use of a pocket-size ultrasound in patients admitted in cardiac unit for chest pain did not alter significantly the initial cardiologists diagnosis in comparison with the usual evaluation (physical examination, troponin levels, and electrocardiogramt).

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Changes in myocardial deformation assessed by 2D and 3D speckle tracking echocardiography in asymptomatic type 1 diabetic patients

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Aims In this study, we sought to assess left ventricular (LV) function using two-dimensional (2D) and three-dimensional (3D) speckle tracking echocardiography (STE) for the detection of preclinical diabetic cardiomyopathy, in asymptomatic type 1 diabetic patients, and to evaluate evolution over a 6-year follow-up.

Methods and results 66 asymptomatic type 1 diabetic patients with no cardiovascular risk factors were compared to 26 matched healthy controls. Conventional, 2D and 3D STE were performed at baseline. A subgroup of 14 patients underwent a 6-year follow-up evaluation. At baseline, diabetic patients had similar LV ejection fraction (60 vs. 61%; p=NS), but impaired longitudinal function, as assessed by 2D global longitudinal strain (GLS) (–18.9±2 vs. –20.5±2; p=0.0002) and 3D GLS (–17.5±2 vs. –19±2; p=0.003). At follow-up, diabetic patients had worsened longitudinal function compared to baseline (2D GLS: –18.4±1 vs. –19.2±1; p=0.03). Global circumferential (GCS) and radial (GRS) strains were unchanged at baseline and follow-up. Metabolic status did not correlate with GLS, whereas GCS and GRS showed a good correlation, suggestive of a compensatory increase of circumferential and radial function in advanced stages of the disease – long-term diabetes (GCS: –26±3 vs. –23.3±3; p= 0.008) and in the presence of microvascular complications (GRS: 38.8±9 vs. 34.3±8; p=0.04).

Conclusion Subclinical myocardial dysfunction can be detected by 2D and 3D STE in type 1 diabetic patients, independently of any other cardiovascular risk factors. Diabetic cardiomyopathy progression was demonstrated by a significant echocardiographic deterioration at follow-up, but did not extend to a clinical expression of the disease.

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Non-invasive multi-modality imaging evaluation of pulmonary arterial elastance in patients with pulmonary hypertension

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Introduction Effective pulmonary arterial elastance [(Ea: end-systolic pressure (ESP) /stroke volume (SV)] reflects a global measure of total afterload. In pulmonary hypertension (PH), ESP is best approximated by pulmonary artery mean pressure (mPAP). Along with SV, both are ideally assessed during right heart catheterization (RHC). Novel imaging modalities, mainly phase contrast (PC) MRI, may offer new insights in Ea estimation through non-invasive surrogates.

Purpose To test if pulmonary artery elastance can be assessed non-invasively as the ratio of mean pulmonary artery pressure issued from trans-thoracic echocardiography (TTE) to stroke volume estimated either by PC-MRI or TTE.

Methods 121 patients were evaluated for group 1 and 4 PH with multimodal imaging and RHC within 48 hours. mPAP was estimated using 2 validated methods: the Chemla's formula (mPAP=0.61 x sPAP + 2 mmHg), mean tricuspid regurgitation (TR) gradient added with estimated right atrial pressure based on inferior vena cava. Right ventricle (RV) SV was either measured by PC MRI or extrapolated from Doppler left ventricle (LV) output track SV.

Results There were good correlations and concordances between RHC and non-invasive derived Ea using TTE mPAP/MRI RV SV (TR: n=96, r2=0.805, Chemla's formula, n=100, r2=0.807). Correlations were significant but weaker when using TTE derived LV SV (TR: n=98, r2=0.630; Chemla's formula: n=102, r2=0.673).

Conclusion Ea defined as the ratio of echocardiographic mPAP (mean TR gradient or Chemla's formula) and PC-MRI SV correlated well with gold-standard RHC invasive values. Added to other parameters of RV morphology and performance, non-invasive Ea may help further estimation of right ventriculo-arterial coupling in PH.

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Diagnostic accuracy of cardiovascular screening using pocket-size ultrasound in patients with dyspnea in the emergency setting

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Purpose Dyspnea in the emergency department (ED) setting requires a rapid and accurate diagnosis to start an appropriate treatment. We aimed